36x0 Store 12-03-02
Investigate response of SBD

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12-08-02

BACKGROUND:

The SBD reports the bunch intensity of both protons and pbars. With a proton only store it is easy to check the calibration of this device at both the 150 GeV front porch during proton injection and after acceleration to 980. Previous measurements where the protons and pbars are untangled have shown a 5% decrease in the sensitivity of the SBD.

EXPERIMENT:

Protons were injected as 36 coalesced bunches and accelerated to 980 GeV. I'm note sure, but it looks like there was also a low beta squeeze and a scrape. The plots from page D44 are shown on the last page. The traces shown are:

T:IBEAM	Every 1 sec.
T:SBDNAR	The narrow gate SBD output every 15 sec.
T:SBDPIS	There are only points at 15 minutes available.
C:FBIPNG	Fast bunch integrator, narrow gate, at 15 sec.
T:IRING	Marks when acceleration took place, 15 sec.
T:SBDPSS	RMS proton bunch width from SBD, 15 sec.
T:SBDBNA	Pbar output from SBD to check for cross talk.

In addition, I had 4 files of raw SBD data, two at 150 GeV and two at 980 giving points at 0.5 ns.

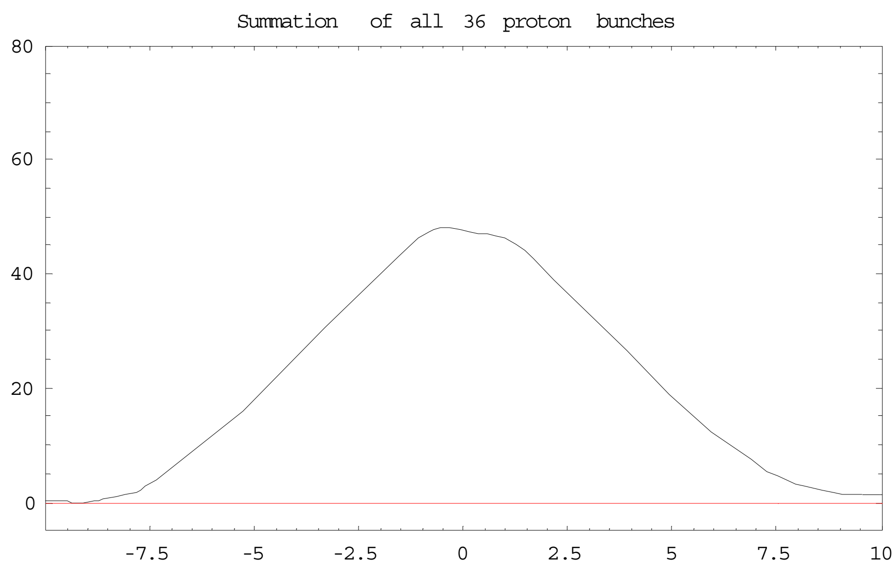
ANALYSIS:

The SBD files were analyzed in the following way:

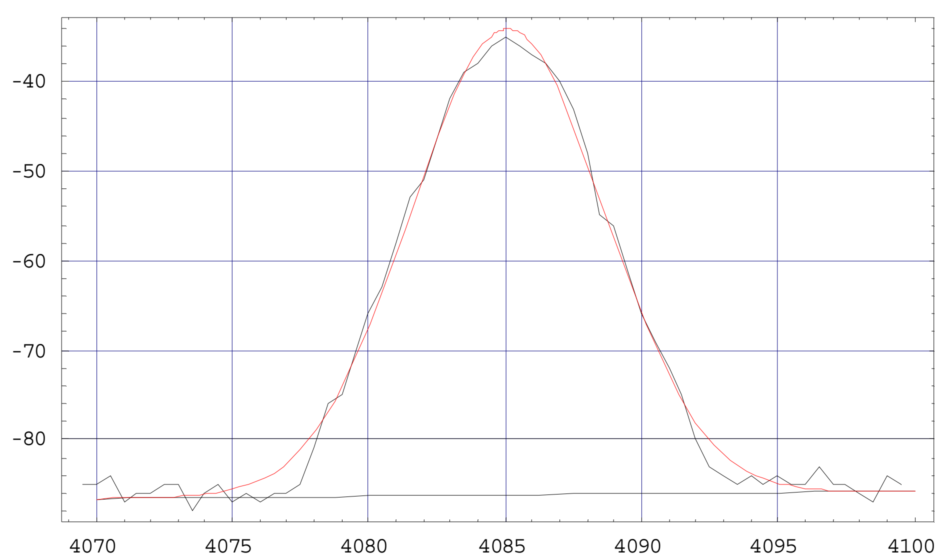
1. The files cut into snips around the individual pulses.
2. A 5 parameter fit involving a constant plus linear slope plus a Gaussian is fit to all 36 bunches. This yields the centroid of each bunch with a variance of 9 ps at 150 and 2 ps at 980.
3. An interpolation function was then generated using the raw data. This gives a time continuous representation of the data using a 3rd order interpolation routine.
4. Using the centroid information from the Gaussian fit, the bunches are superimposed.

The result of this is shown below:

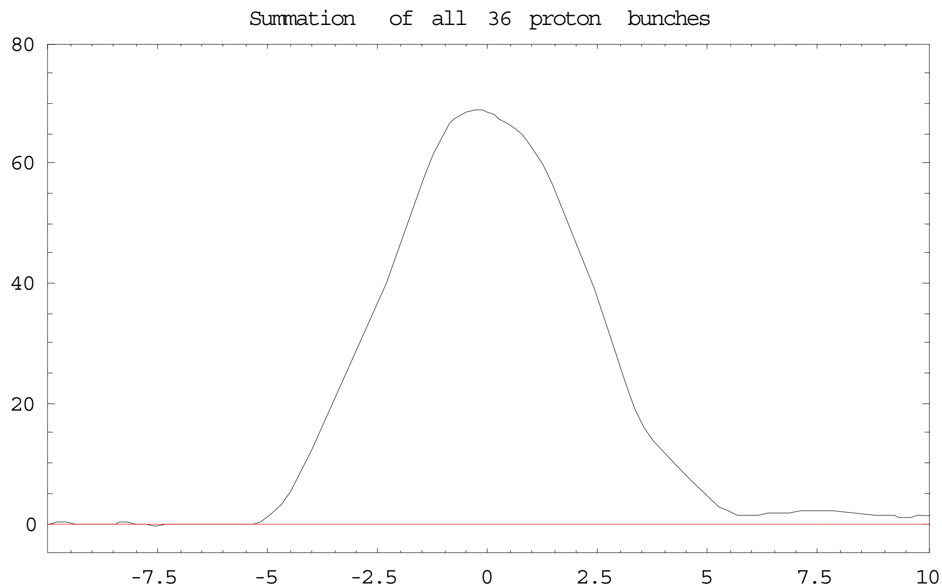
150 GeV (This is not a fit, it is a superposition of raw data):



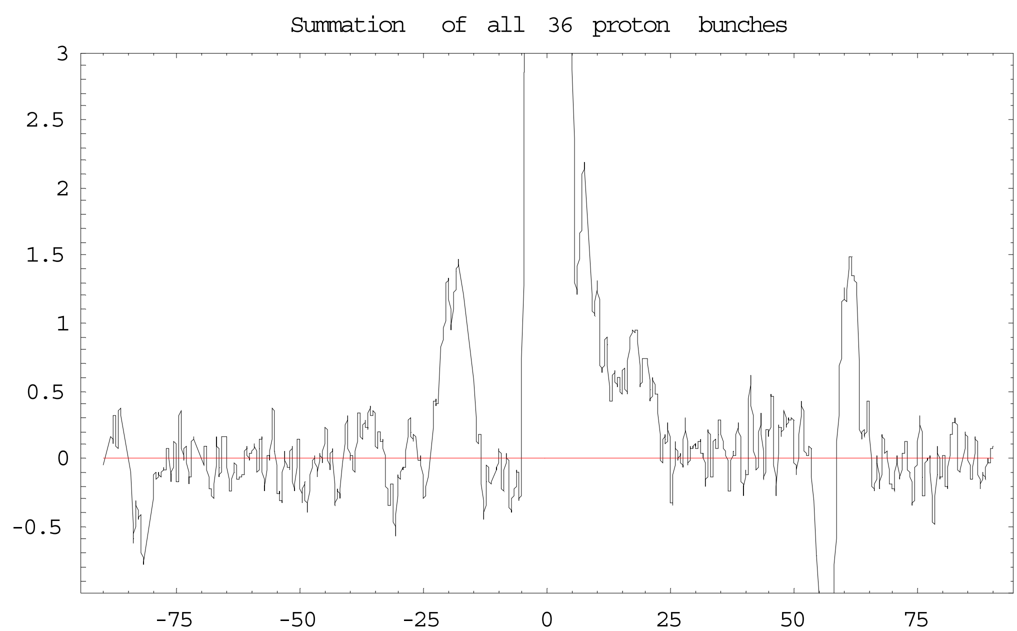
For reference, the plot below shows a Gaussian fit to one of the bunches at 150 GeV. Note that it pretty nearly fills the bucket:



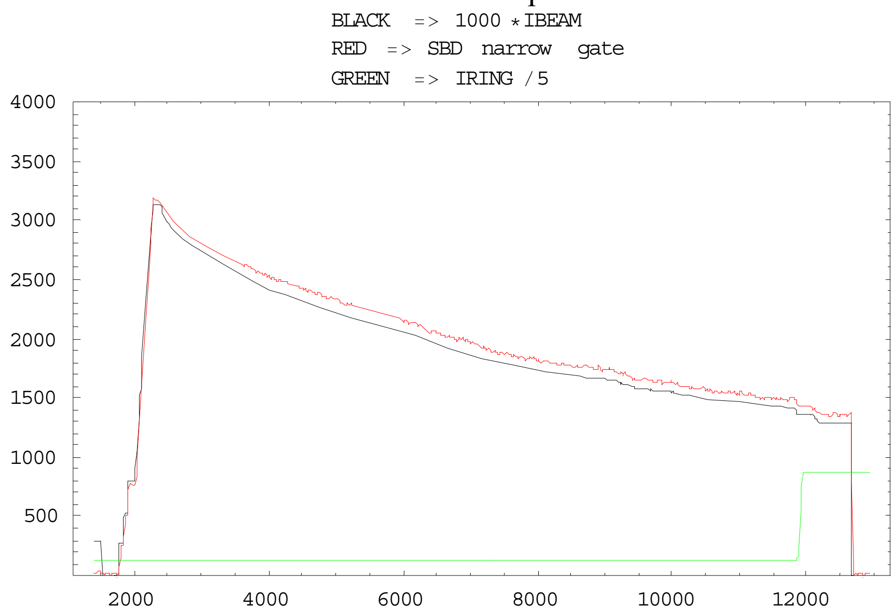
At 980:



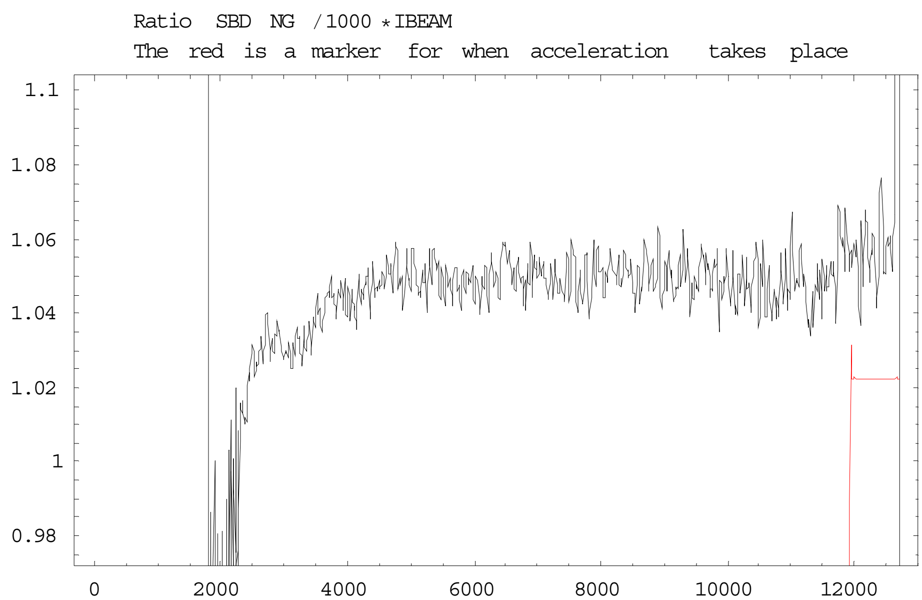
Expanding the vertical scale shows the results of the bad termination near the scope. This is being cleaned up. A small satellite bunch is clearly visible before the main bunch, but anything on the back side is obscured by reflections.



Next we show the data as a function of time during the store. The data come from the internal SBD programs and give similar results to the plots shown above. IBEAM, SBDNAR and IRING/5 are shown in the plot below:



Acceleration and low beta are near the end. The next plots show the ratio of the two proton flux variables. It is already clear from the plot above that the ratio is slightly bigger than 1.0.



The response during injection is partly an artifact of the analysis and will not be pursued here. What is surprising is that during acceleration there is only a small change in the ratio of SBD to IBEAM. Several conclusions can be reached:

1. There was a concern that maybe magnetic fields were interfering with the IBEAM current transformer. This is ruled out to the 1% level.
2. A plot of T:IBEAM during acceleration shows only a 3% loss of beam and the ratio above may increase by 1%. This could be due to some DC beam stored in the machine during injection.
3. The most surprising thing is that there is no 5% change in the SBD. This is completely at variance with what is observed with pbars in a normal store. Curves for a normal store 2019 are shown below. The first shows T:IBEAM during the front end injection of protons and pbars. The second shows an analysis that is detailed in the notes to the Thursday 2:30 pm meeting of Dec 5. The part of the store where protons are injected allows a direct check of the SBD relative to IBEAM at 150 GeV. The analysis is done using the following equations where a is a calibration constant for the SBD that normalizes it to IBEAM and r is the ratio of p/pbar as measured in the SBD. During proton injection, r is zero so the SBD can be directly calibrated by the second and forth equation. After pbars are injected, r is obtained from the SBD and the equations solved for a.

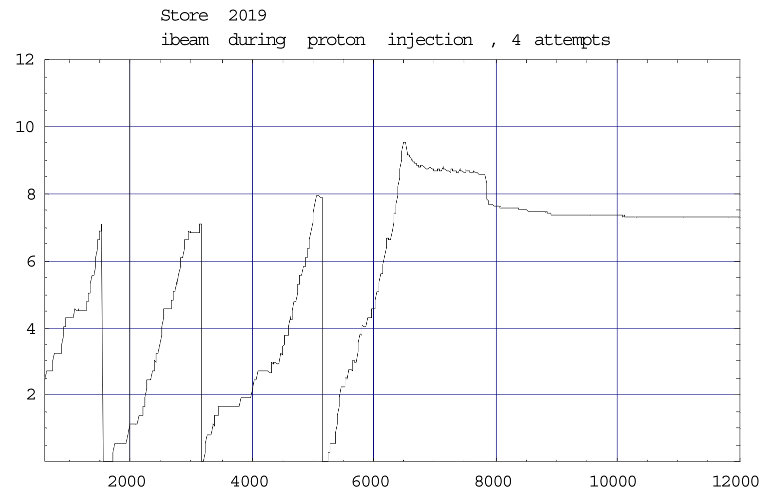
$$Ibeam = P + \overline{P} = P(1 + \frac{\overline{P}}{P})$$

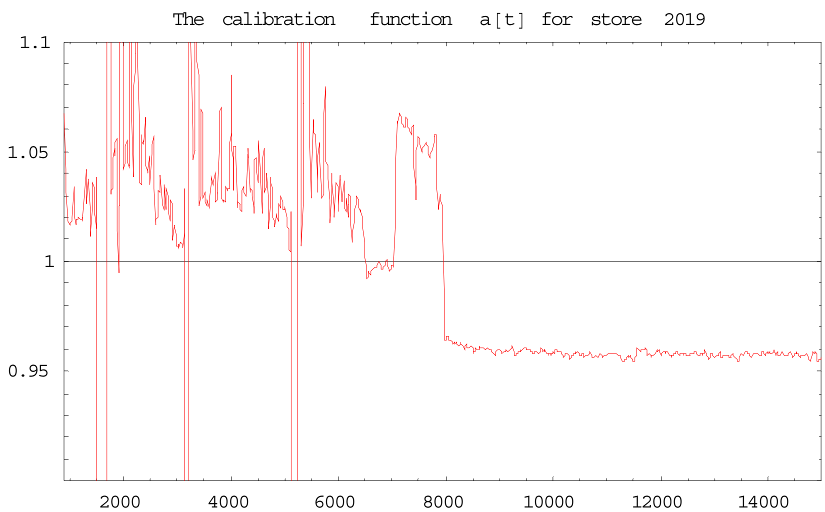
$$P = Ibeam/(1+r)$$

$$Pbar = r \times Ibeam/(1+r)$$

$$P = a \times P_{SBD};$$

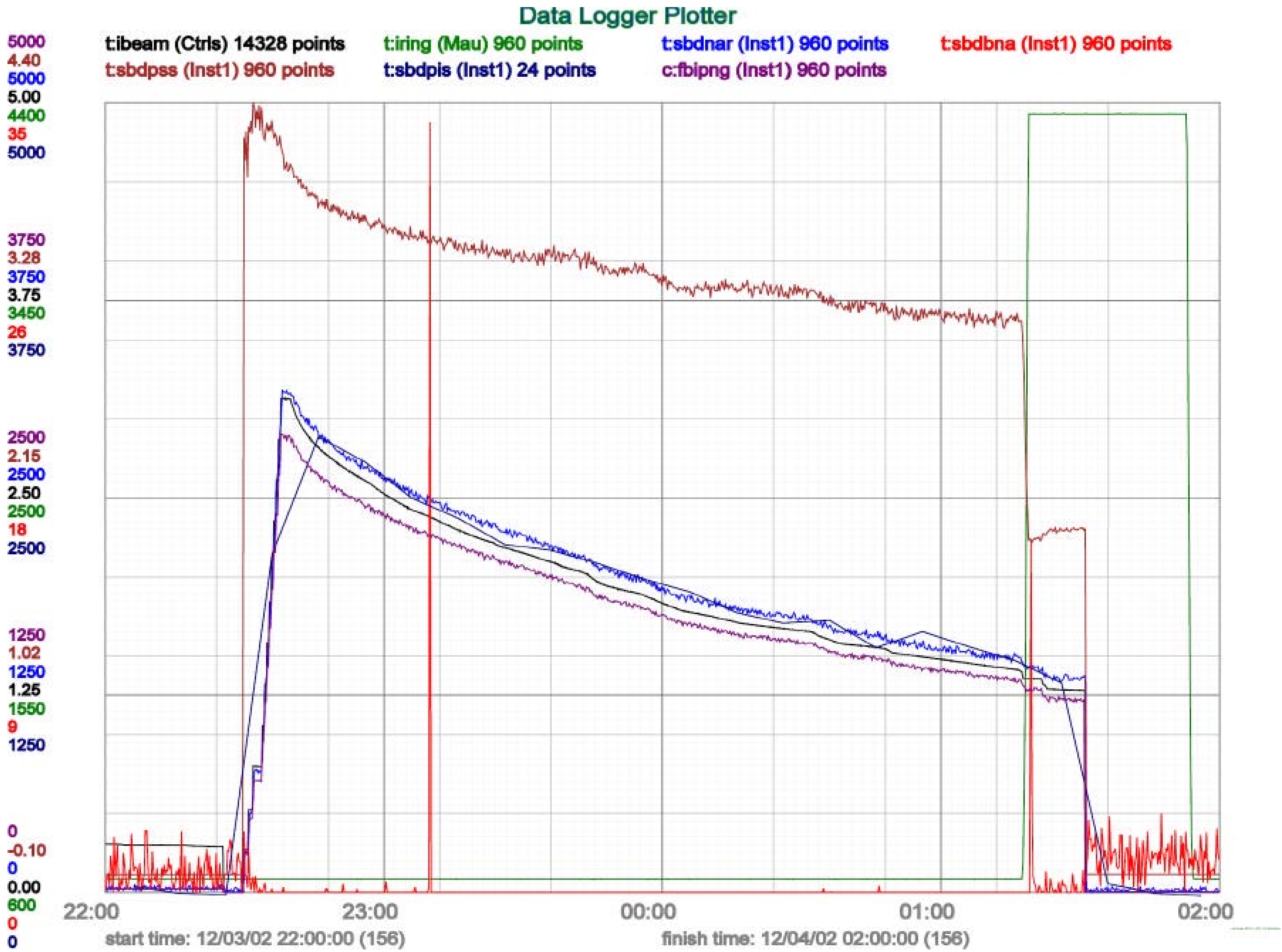
$$Pbar = a \times Pbar_{SBD}$$





The SBD for this run is reading 2-3% low during proton injection. There is trouble at the start of the 3rd pbar injection a little past 6000. There is additional trouble after acceleration when the SBD is reading 5% high.

The above behavior is not seen in the proton only store where the calibration constant is nearly constant from 150 to 980. The trouble is not understood.


Data Logger Plotter
t:ibeam (Ctrls) 14328 points
t:iring (Mau) 960 points
t:sbdnar (Inst1) 960 points
t:sbdbna (Inst1) 960 points
t:sbdpss (Inst1) 960 points
t:sbdpis (Inst1) 24 points
c:fbipng (Inst1) 960 points
5000
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35
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3750
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3750
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start time: 12/03/02 22:00:00 (156)
finish time: 12/04/02 02:00:00 (156)